Rachel Denholm, Richard Morris, Sarah Purdy and Rupert Payne

Impact of emergency hospital admissions on patterns of primary care prescribing:

a retrospective cohort analysis of electronic records in England

Abstract

Background
Little is known about the impact of hospitalisation on prescribing in UK clinical practice.

Aim
To investigate whether an emergency hospital admission drives increases in polypharmacy and potentially inappropriate prescriptions (PIPs).

Design and setting
A retrospective cohort analysis set in primary and secondary care in England.

Method
Changes in number of prescriptions and PIPs following an emergency hospital admission in 2014 (at admission and 4 weeks post-discharge), and 6 months post-discharge were calculated among 37 761 adult patients. Regression models were used to investigate changes in prescribing following an admission.

Results
Emergency attendees surviving 6 months (N = 32 657) had a mean of 4.4 (standard deviation [SD] = 4.6) prescriptions before admission, and a mean of 4.7 (SD = 4.7; P<0.001) 4 weeks after discharge. Small increases (<0.5) in the number of prescriptions at 4 weeks were observed across most hospital specialties, except for surgery (−0.02; SD = 0.65) and cardiology (2.1; SD = 2.6). The amount of PIPs increased after hospitalisation; 4.0% of patients had ≥1 PIP immediately before pre-admission, increasing to 8.0% 4 weeks post-discharge. Across hospital specialties, increases in the proportion of patients with a PIP ranged from 2.1% in obstetrics and gynaecology to 8.0% in cardiology. Patients were, on average, prescribed fewer medicines at 6 months compared with 4 weeks post-discharge (mean = 4.1; SD = 4.6; P<0.001). PIPs decreased to 5.4% (n = 1751) of patients.

Conclusion
Perceptions that hospitalisation is a consistent factor driving rises in polypharmacy are unfounded. Increases in prescribing post-hospitalisation reflect appropriate clinical response to acute illness, whereas decreases are more likely in patients who are multimorbid, reflecting a focus on deprescribing and medicines optimisation in these individuals. Increases in PIPs remain a concern.

Keywords
hospital admission; hospital emergency service; inappropriate prescribing; polypharmacy; primary health care.

INTRODUCTION

Prescribing is the major therapeutic intervention available to clinicians, with most occurring in primary care where long-term conditions are increasingly managed. Medication use is steadily growing: the proportion of UK patients receiving ≥5 drugs doubled between 1995 and 2010.[1] Prescribing of multiple medications (polypharmacy) is driven by several factors, including an ageing population, multimorbidity, and single-condition, guideline-driven prescribing.[2,3] Polypharmacy is, in turn, associated with medication errors,[4] adverse reactions,[5] a reduced quality of life,[6] and impaired medication adherence.[7]

Care transitions can impact on the quality and continuity of pharmacotherapy. Previous research has found that many patients experience changes to their medication regimen after hospitalisation,[8] with extensive changes occurring at discharge,[9,10] including increases in the number of potentially inappropriate prescriptions (PIPs),[11,12] where the risks associated with a prescription outweigh the benefits, such as prescribing in the context of a recognised contraindication.[11–13] Given differences in health service structures and processes, it is unknown whether these issues are observed in UK practice. Furthermore, previous work has had important limitations, including relatively small populations, limited clinical focus, or ecological methods.

Improving understanding of changes in medication following hospitalisation is relevant as it can inform medicine reconciliation, an important and improvable aspect of high-quality care.[14] This study aimed to examine the effect of a single emergency admission on changes in overall prescribing and PIPs in UK primary care, including how this varies with hospital specialty.

METHOD

Study population

A descriptive analysis was conducted using anonymised data from the Clinical Practice Research Datalink (CPRD).[15] The CPRD is a database of anonymised UK primary care electronic health records, containing >5 million active patients from approximately 650 general practices, and is representative of the general population.[15,16] The database contains coded data on clinical diagnoses and prescribed medications.

A random sample of 100 000 patients (the maximum available to the study), aged ≥18 years, admitted to hospital in 2014, was identified using linked Hospital Episode Statistics (HES) data. Analysis was restricted to emergency admissions. HES contains coded data (dates, diagnoses, hospital specialty) on most English hospital inpatient admissions.[17] The first hospital admission, including readmissions within 6 weeks of discharge, was defined as the index admission. Patients were excluded if hospitalised within 1 year before the index admission to ensure changes to prescriptions

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How this fits in

Evidence from Australia, Canada, and Europe suggests transitions between primary and secondary care impact on the quality and continuity of medication therapy. Findings from this study, the first, to the authors' knowledge, to investigate the impact of an emergency hospital admission on changes to prescribing in primary care in England, indicate that prescribing increases after discharge, but then falls to pre-hospital levels 6 months later. Potentially inappropriate prescribing increases following a hospital admission, both in the short and long term.

were not influenced by previous hospital stays. Maternity admissions specifically relating to childbirth were excluded.

Table 1. Characteristics of patients having an emergency admission to hospital, *N* = 32 657[a]

Characteristic	*n* (%)[b]
Sex	
Male	15 027 (46.0)
Female	17 630 (54.0)
Age at admission, years	
Mean (SD)	58.7 (21.3)
Median (IQR)	60 (41 to 77)
Multimorbidity scores	
0	8648 (26.5)
1	7463 (22.9)
2	6424 (19.7)
3	4542 (13.9)
4	2797 (8.6)
≥5	2783 (8.5)
Number of prescriptions before hospitalisation	
0	8466 (25.9)
1–3	6345 (19.4)
4–6	4691 (14.4)
7–9	8407 (25.7)
10–14	3647 (11.2)
≥15	1101 (3.4)
Index hospitalisation factors	
Duration of hospitalisation, days	
Mean (SD)	6.4 (17.0)
Median (IQR)	2 (0 to 6)
Number of admissions during hospitalisation	
Mean (SD)	1.4 (2.4)
Median (IQR)	1 (1 to 1)
Number of admissions within 6 months of discharge	
0	25 189 (77.1)
1	5125 (15.7)
≥2	2343 (7.2)

[a]Index hospital admission defined as first hospitalisation of 2014 (with no hospitalisation in the previous 6 months) and includes any hospital admissions within 6 weeks of discharge. Multimorbidity list includes 37 chronic conditions.[23] [b]Unless otherwise stated. IQR = interquartile range. SD = standard deviation.

Measurements

The number of (ongoing) prescriptions were ascertained at index admission, and at 4 weeks and 6 months post-discharge. An ongoing prescription was defined as one where the period of time over which it was used included the date of interest. Prescription length was calculated by dividing drug quantity by number of daily doses; where missing, a population average was used. Prescriptions were categorised according to the British National Formulary (BNF),[18] and limited to pharmacological products (BNF chapters 1–15).

Counts of all ongoing prescriptions were calculated at each time point, stratified by BNF chapter. A categorical count of all ongoing prescriptions of unique drugs at index admission based on pragmatic and clinical judgement was created, grouping 0, 1–3, 4–6, 7–9, 10–14, and ≥15 prescriptions. Two continuous measures detailing the change in number of prescriptions relative to index admission in the short term (4 weeks) and long term (6 months) were created and grouped into five categories (reductions of 1 drug, or ≥2 drugs, no change, increases of 1 drug, or ≥2 drugs).

PIPs were based on 19 Royal College of General Practitioners (RCGP) inappropriate prescribing indicators,[19,20] which were used in the PINCER trial[21] and that are currently being implemented in UK clinical practice. These indicators included prescribing in the context of particular contraindications, for example, beta-blockers and asthma, or drug–drug interactions, such as warfarin with non-steroidal anti-inflammatory drugs (NSAIDs).[19] Binary measures detailing whether the patient had ≥1 PIP at the index admission at 4 weeks and 6 months post-discharge were created.

Hospital specialty, that with primary responsibility for patient care, was based on the longest episode of care during a given admission and grouped according to national patterns[22] (Supplementary Table S1). Individual specialties, that is, gastrointestinal/respiratory, were grouped together, except for cardiology after initial investigation found little differences in prescribing across specific specialties. Duration of index hospitalisation was also calculated along with number of readmissions and number of admissions within 6 months of discharge. A list of 37 physical and mental long-term conditions established by clinical expert consensus was used to ascertain comorbidity status at hospitalisation.[23–25] A simple, unweighted count of clinical conditions was derived, and a six-category measure (0–≥5 conditions) created.

Statistical analysis

Descriptive analyses were used to explore prescribing patterns before and after the index admission. Analyses were restricted to patients who survived 6 months post-discharge. Multilevel linear regression models were fitted to the outcomes (change in number of prescriptions at 4 weeks compared with at index admission; 6 months compared with 4 weeks post-discharge) by hospital specialty. Marginal effects were estimated and represent a change in the number of prescriptions by the exposure of interest, keeping other covariates at their observed levels, and averaged across patients. Multilevel logistic regression was used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) of having a PIP at 4 weeks compared with index admission, and at 6 months compared with 4 weeks post-discharge, by hospital specialty. In both models, covariates were included as fixed effects, with a random intercept term for general practice to adjust for clustering. Age and number of prescriptions at index admission were standardised using respective sample mean values and standard deviations (SD). All continuous measurements were grouped into relevant categories or quartiles. Interaction terms were used to investigate non-linear associations and the most appropriate, as determined using likelihood ratio tests, are presented. Data analysis was conducted in Stata (version 15). Statistical tests were two-sided.

Sensitivity analysis

The authors repeated models, including all patients alive at 4 weeks post-discharge, to assess whether restricting analysis to patients who survived 6 months post-discharge biased the estimates. Regression to the mean (extreme values moving towards the average when measured repeatedly on the same subject) was explored across grouped number of prescriptions before hospitalisation, and expected and observed estimates compared.

RESULTS

Study population characteristics

A total of 37 761 emergency attendances were found, of which 34 815 and 32 657 were alive at 4 weeks and 6 months post-discharge, respectively. On average, patients who survived at 6 months post-discharge, compared with patients who died (n = 5115), had fewer prescriptions at hospitalisation (mean = 4.4; SD = 4.6 versus mean = 6.3; SD = 4.7), and fewer comorbidities (≥5 conditions: 8.5% versus 18.1%; P<0.001). For those patients surviving 6 months, hospital emergency attendees had a mean age of 58.7 (SD = 21.3) years, 54.0% were female, and 50.7% had ≥2 comorbidities (Table 1). Average duration of hospitalisation was 2 days (interquartile range = 0 to 6), and 22.9% of patients were re-admitted within 6 months post-discharge.

Number of prescriptions following hospital discharge

Emergency attendees had a mean of 4.4 (SD = 4.6) prescriptions before admission and a mean of 4.7 (SD = 4.7; P<0.001) 4 weeks after discharge. Following hospitalisation, increases in prescribing were observed in all patients across sex, age, and multimorbidity status (Supplementary Figure S1).

Patients prescribed fewer medications before a hospital admission were prescribed more after, whereas those prescribed more received fewer following hospitalisation. Observed findings were compatible with regression to the mean (Supplementary Table S2).

The number of drugs pre-hospitalisation varied across hospital specialties (Figure 1). Small increases (<0.5) in the number of prescriptions at 4 weeks post-discharge, compared with pre-admission, were observed for most specialties, except for surgery (−0.02; SD = 0.65) and cardiology (2.1; SD = 2.6).

Overall, 57.1% (n = 18 636) of patients had a change in the number of prescriptions following hospitalisation, ranging from 51.0% in obstetrics and gynaecology (O&G) (n = 721/1415) to 83.5% in cardiology (n = 1269/1520) (Figure 2). Of those patients treated in cardiology, 53.7% (n = 816) had ≥2 additional prescriptions. Admissions under O&G had the greatest proportion of patients with ≥2 fewer prescriptions at 4 weeks post-discharge at 6.5% (n = 92). In adjusted models, the average change in number of prescriptions following hospitalisation was relatively small (<0.5) across most specialties (Supplementary Figure S2). Only surgery showed a slight decrease in prescribing (−0.17; 95% CI = −0.24 to −0.09). Cardiology demonstrated a marked increase of 2.16 (95% CI = 2.04 to 2.27) prescriptions.

Potentially inappropriate prescribing following hospital discharge

There was an increase in the proportion of patients who had PIPs from 4.0% pre-admission to 8.0% immediately at 4 weeks post-discharge (Figure 3). The most marked

Figure 1. Mean number of prescriptions before and after hospitalisation stratified by hospital specialty and BNF chapter. Index hospital admission defined as first hospitalisation of 2014 (with no hospitalisation in the previous 6 months) and includes any hospital admissions within 6 weeks of discharge. Patients restricted to those who were still alive 6 months post-discharge (N = 32 657). Hospital specialty based on longest episode of care and grouped according to national frequency emergency admissions (Supplementary Table S1).
BNF = British National Formulary. CNS = central nervous system. CV = cardiovascular.
GI = gastrointestinal. MSK = musculoskeletal.
O&G = obstetrics and gynaecology.

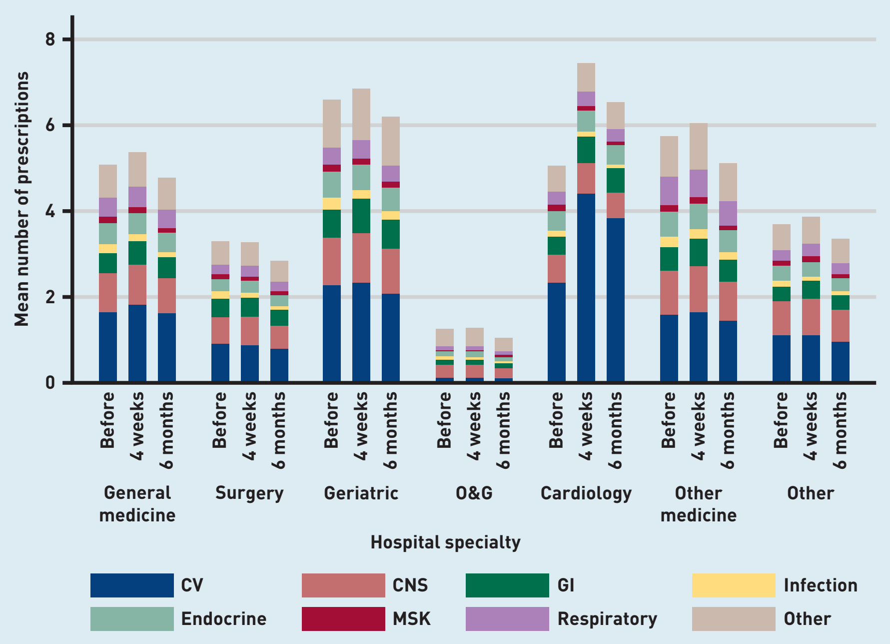
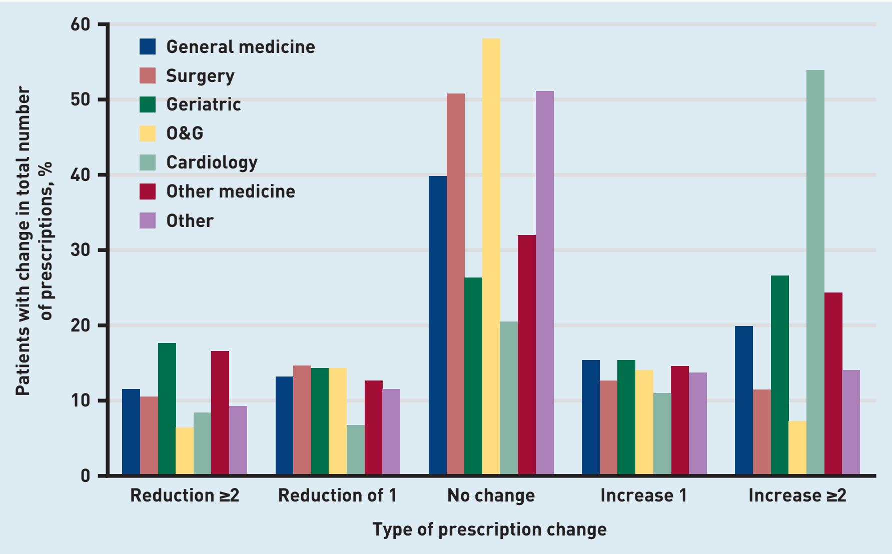


Figure 2. Change in total number of prescriptions at 4 weeks post-discharge compared with hospitalisation among emergency attendees stratified by hospital specialty. Index hospital admission defined as first hospitalisation of 2014 (with no hospitalisation in the previous 6 months) and includes any hospital admissions within 6 weeks of discharge. Number of prescriptions includes all ongoing prescriptions on the date of interest. Patients restricted to those who were still alive 6 months post-discharge (N = 32 657).
O&G = obstetrics and gynaecology.



increases were observed for patients with a history of heart failure and prescribed an NSAID (RCGP indicator 6) (3.0%; $n = 12/403$ to 7.4%; $n = 139/1890$), and patients prescribed warfarin and aspirin without gastroprotection (RCGP indicator 10) (0.8%; $n = 8/944$ to 4.2%; $n = 47/1123$). Similar patterns were observed across hospital specialty, with increases ranging from 0.9% to 3.0% in O&G and from 5.5% to 13.4% in cardiology.

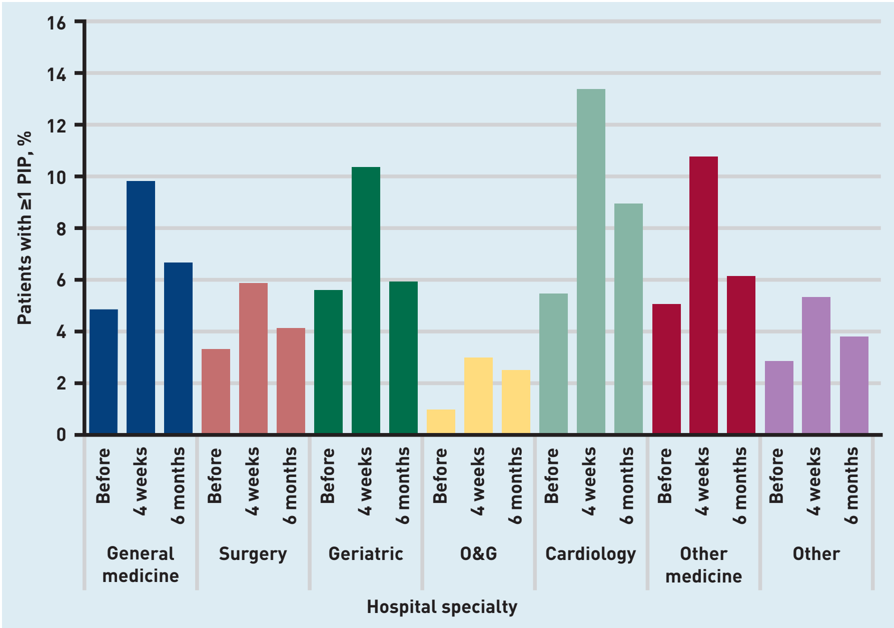
In adjusted models, the OR of receiving a PIP was 2.01 (95% CI = 1.93 to 2.23) at 4 weeks post-discharge, compared with pre-admission. The risk of having a PIP was comparable across most hospital specialties (Supplementary Figure S3), except for O&G for which the risk was higher owing to low pre-admission prescribing.

Sustained changes in prescribing 6 months after hospitalisation

Fewer medicines were prescribed at 6 months post-discharge than at pre-admission and at 4 weeks post-discharge (mean = 4.1; SD = 4.6); 60.4% of patients ($n = 19\ 726$) had ≥1 additional or removed medication, compared with 4 weeks post-discharge (Figure 4). Decreases in prescribing at 6 months were observed in older patients, those diagnosed with ≥3 comorbidities, and patients prescribed ≥7 medicines at hospitalisation (Supplementary Figure S4). The latter was lower than expected given regression to the mean estimates (Supplementary Table S2).

The decrease in medicines at 6 months, compared with immediately post-discharge, persisted across specialties (Figure 1), ranging from 0.2 (SD = 1.6) in O&G to 0.9 (SD = 3.5) in both cardiology and other medicines. In an adjusted model, the average patient was prescribed 0.77 (95% CI = 0.63 to 0.92) fewer medications at 6 months, compared with 4 weeks post-discharge (Supplementary Figure S5). PIPs decreased to 5.4% of patients ($n = 1751$) by 6 months, though this was still higher than at admission. After adjusting, the OR for a PIP at 6 months compared with one at 4 weeks post-discharge was 0.70 (95% CI = 0.66 to 0.75), with little difference across specialties (Supplementary Figure S6).

Figure 3. Percentage of patients who had ≥1 potentially inappropriate prescription (PIP) pre-hospitalisation at 4 weeks and at 6 months post-discharge stratified by hospital specialty. Prescribing safety indicator (composite measure of indicators P1–P19)[19] used to identify potentially inappropriate prescribing. Patients restricted to those who were still alive at 6 months post-discharge.
O&G: obstetrics and gynaecology.



Sensitivity analysis

No differences were observed when analysis was repeated including all patients alive at 4 weeks post-discharge (data not shown).

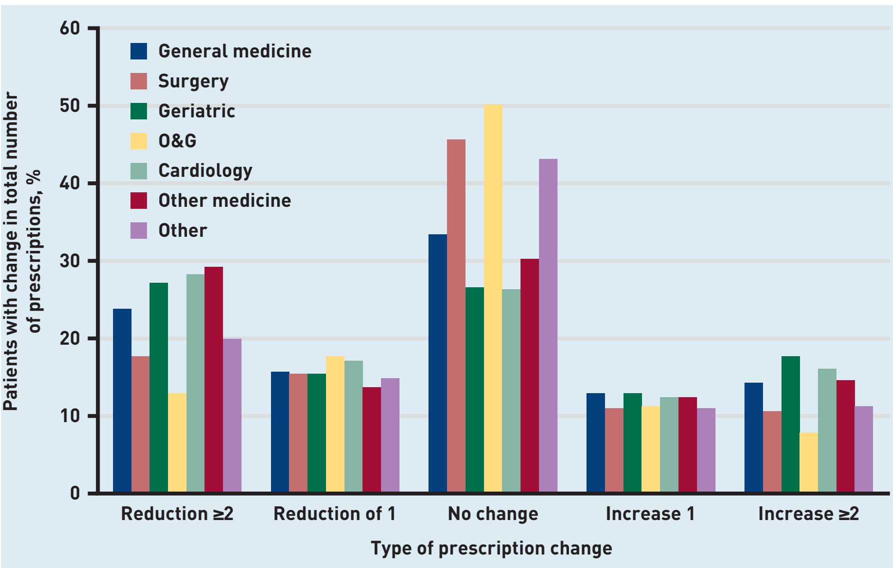
DISCUSSION

Summary

This study is the first to assess the impact of emergency hospitalisation on prescribing in primary care in the general English population, finding that overall prescribing increased following discharge but fell to below pre-hospital levels within 6 months. There was little variation in prescribing changes across hospital specialty, except for cardiology admissions where statistically significant long-term increases in prescribing were observed. Overall, PIPs increased following a hospital admission, both in the short and long term.

Hospitalisation is associated with significant changes to medication regimens, particularly for certain patient groups and hospital specialties. Perceptions that a hospital admission is a consistent factor driving rises in polypharmacy are unfounded. Increases in PIPs remain a concern. Health services need to consider improved, targeted medication optimisation strategies for those patients discharged from hospital who are most likely to experience changes to their medications.

Figure 4. Change in total number of prescriptions at 6 months post-discharge compared with at 4 weeks post-discharge, among emergency attendees, stratified by hospital specialty. Index hospital admission defined as first hospitalisation of 2014 (with no hospitalisation in the previous 6 months) and includes any hospital admissions within 6 weeks of discharge. Thus, discharge date is based on last hospital admission. Number of prescriptions includes all ongoing prescriptions on the date of interest. Patients restricted to those who were still alive 6 months post-discharge (N = 32 657).



Strengths and limitations

To the authors' knowledge, this is one of the largest studies to investigate changes in prescribing following emergency hospitalisation, to explore differences by hospital specialty, and include younger patients. Detailed data on medical history, all primary care prescribing (as electronic prescribing is ubiquitous in the UK), and hospital admissions were available.

An important first limitation was that actual discharge prescriptions could not be determined but rather what the GP elected to prescribe post-discharge, which might not reflect hospital recommendations. Nevertheless, this study provides detailed insights into changes that occur shortly after discharge, which are highly relevant in understanding priorities for medicines reconciliation.

Second, there is no single accepted means of quantifying amount or appropriateness of medicine use in routine data. The measure in this study is thus a compromise, including broad counts of medicines that provide little insight into appropriateness and narrower specific measures of PIPs that are already used to inform UK medicines optimisation. In addition, PIPs may be offset by therapeutic benefits, but assessing the risk–benefit balance was not possible.

Third, the authors elected to exclude those cases where a prior admission had occurred in the previous year. This allowed the authors to more readily attribute changes in prescribing to a discrete admission but may have excluded patients with potentially more complex health needs, thus limiting generalisability. Average emergency admission length in England has previously been reported as 7.5 days in 2015/2016,[26] which is slightly greater but nevertheless comparable with that found in the present study of 6.4 days.

Finally, the present study did not include a comparative group; therefore, the authors cannot be sure whether changes observed were attributable to the hospital admission or other factors that occurred in the care process during the same period.

Comparison with existing literature

The number of drug changes pre- and post-hospitalisation range from 0.2[27] to 5.5[28] in the existing literature, with up to 75% of patients experiencing a change.[29] The present study found that approximately 50% of patients had a change in the number of medications following discharge. Following a slight increase in prescribing immediately following discharge, the present study observed a decline 6 months later, consistent with a Swiss study investigating long-term changes to prescribing.[30] Results indicate that initial medication changes are not necessarily sustained, potentially reflecting improvements in patients' health or ongoing medicines optimisation in primary care. Greatest reductions were observed among patients with greater morbidity and higher levels of prescribing, potentially reflecting greater subsequent contact with health services and more opportunities for medication regimen change.

The authors found pre-hospital PIP rates to be comparable with the general UK population (4% versus 5%).[19] PIPs increased after discharge, consistent with observations elsewhere,[11,12] though other studies have reported decreases.[31–33] Disparities likely reflect differences in definitions of PIP (STOPP/Beers criteria[32,33] versus RCGP indicators) and populations studied (older[31–33] versus general population).

Implications for research and practice

Medication reconciliation is a key part of providing high-quality care and optimising prescribing across the primary–secondary care interface. The present study demonstrates that changes in prescribing post-hospitalisation are more frequent in patients who have fewer conditions or those on fewer medications pre-admission. This likely reflects an appropriate clinical response to new acute illness in patients who are usually relatively well, in comparison with a greater focus on deprescribing and medicines optimisation in more multimorbid individuals. The authors observed variation between specialties, with marked increases following discharge from cardiology probably reflecting the associated culture of evidence-based drug use in this specialty.

The lack of a statistically significant reduction in prescribing in patients admitted to geriatric care is more unexpected; it may be a consequence of external pressures on services, reducing opportunities for medicines optimisation, though restrictions to the study population may also be a factor. Increases in PIPs post-discharge are unlikely to be solely a result of increased prescribing, but may reflect a shift in the risk–benefit balance of certain medications, favouring potentially more hazardous prescribing in patients who are acutely ill. However, it also raises concerns that hospital clinicians may not be adequately alert to PIPs, or pressures to minimise hospital stays may be compromising good pharmacological management. Therefore, medication optimisation should be considered a routine part of early post-hospital follow-up targeted at patients most likely to be subject to changes in medication and PIPs.

However, whether early intervention impacts on long-term changes in prescribing that were observed post-discharge in this study is unclear and requires further study.

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Ethical approval

Approval was granted by the Clinical Practice Research Datalink Independent Scientific Advisory Committee (protocol: 16_180)

Provenance

Freely submitted; externally peer reviewed.

Competing interests

The authors have declared no competing interests.

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